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WATER POLLUTION AND FISH LIFE[1]

By Victor E. Shelford

The United States Fish Commission is urging the public to eat fish—to make every day a fish day. This was once the case. In a great strike of apprentices in the early days of the republic one of their chief demands was that they receive salmon only three times a week. The richness of the fish supply of our eastern states in the colonial days and early days of the republic can scarcely be appreciated. One author said of the shad in the Susquehanna and Delaware Rivers:

> They came in such vast multitudes that still waters seemed filled with eddies, while the shallows were beaten into foam by them in their struggles to reach their spawning grounds. They swarmed every spring from mouth to head waters of every stream from Maine to Florida.

Shad was an important food fish in the early days of the nation; they were eaten fresh and smoked, and were salted for winter use. During the spring runs people traveled long distances to shoal waters to obtain their winter's supply. Along the Illinois river many years ago the buffalo fish was the chief marketable species. These were caught by farmers, fishermen and others during the breeding season and shipped by boat, principally to St. Louis. No ice was used. The fish were frequently thrown away because they spoiled or the market was overloaded.

Perhaps without mention of these facts, the author's remarks about fish would not mean very much. Americans have been very careless with the fish resources in this country. There was over-catch. Then pollution of water by wastes from manufacturing plants and by sewage of cities completed the work of destruction already started by heedless fishermen, but the pollution of the water is far more serious than over-fishing because it destroys the possibility of easy recovery. It is well to take stock of our knowledge now under pressure of numerous problems demanding immediate solution because of the great war. In connection with the manufacture of munitions, the proposed recovery of grease from sewage, and other activities, some of the most dangerous effluents result, giving us special war problems. The dangers to fishes are increased with the greater need to conserve them. Means of measuring the harm which pollution will cause are needed at once. Our knowledge is incomplete and not organized for the purpose. While it is not difficult to formulate a number of important questions to keep in mind in dealing with water pollution, the answers to most of them demand much investigation. However, the author will outline nine points very important to consider in our efforts to safeguard fishes.

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[1] Read before the Illinois Section, April 16, 1918. A more complete discussion of the nine topics mentioned in this paper 20 being published in the Bulletin of the Illinois State Laboratory of Natural History, Vol. xiii; Art. 2.

1. First of all, some of the wastes introduced into the sea, lakes and streams kill fish and other animals useful for food. Tests of the toxicity of sewage and industrial wastes must be made. In doing this it is not sufficient that one take any fish or other animal he picks up. A fish that is representatively sensitive must be used. For this purpose use young suckers—either the red horse or common sucker. They are not less resistent than some of the plants and animals which constitute the food of fishes and are sufficiently sensitive to afford a good criterion of danger to fishes in general. Among marine animals either fishes or shrimps may be used.

2. There is always a most sensitive period in the life of a fish or other useful animal. This is usually in the young stages. In the case of the clam worm the egg at the time it is laid is about twenty times more resistant than the young larva. Some fishes appear to be most sensitive at the time of hatching and others in the egg stage; this stage may be a hundred times more sensitive than the adult. The most significant thing to know about poisons is the least fatal concentration to the most sensitive stage. In general one should use the youngest test animals he can get, for example the youngest suckers.

3. Conditions in streams and other bodies of water vary; the concentration of the polluting substance should be known. The minimum flow of a stream usually gives the greatest concentration. The summer low-water conditions are dangerous because of little flow and high temperature which increases toxicity; the winter low-water because of slow flow and ice which prevents aeration.

Perhaps something might be done, such as forcing air through the effluent near the point where the pollution is introduced to reduce this danger during critical periods by increasing oxygen and removing carbon dioxide.

4. The removal of constituents and the results of treatment of various polluting substances must be fully analyzed. It is necessary to know the results of treatment of sewage, industrial wastes, etc., in terms of their effects on useful aquatic animals. If coal tar wastes are partially recovered it is necessary to know whether the residue is still toxic. Experiments have shown that nearly all constituents are, and hence any residue will be almost certain to be poisonous. Effluents which result from the Miles acid process of sewage treatment must receive special consideration, because acid effluents such as result from it are very poisonous, particularly those resulting from the use of SO_2. Such questions as how much acid will the water neutralize, how much CO_2 is liberated, and the like, must be answered. Also which is the more toxic, H_2SO_3 or H_2SO_4? From existing knowledge it appears that sulphites and acid sulphites are far more toxic than sulphates.

5. The substances which are introduced into the water not only affect fishes directly but also act through effects on the bottoms on which eggs rest. Lake Michigan once produced numerous white-fish. The number of whitefish has been greatly reduced. The reasons are not only over-catch but also the covering up of breeding bottoms with a large amount of sawdust and other rubbish which makes the spawning grounds useless. Some of this bottom can never be recovered, at least, not for a long time.

6. The reaction of the animals demands attention. Both fresh water and marine fishes react negatively to acids, i.e., they turn back when they encounter them. Freshwater fishes will not enter any but the weakest concentration; marine pelagic fishes select alkaline water. In the fourteenth century, about the time the Baltic towns of the Hanseatic League, which depended upon the herring industry, were at their most prosperous stage, herring began to leave the locality and are supposed to have migrated to the North Sea. Herring were at one time very abundant in places which are now practically deserted. Herring invariably select a slightly alkaline water and avoid acids which result from contamination. The New Jersey Mosquito Commission finds that the acids thrown into the coast waters by munition works repels the killifishes on which

they depend to keep the mosquitoes down. There is also a different danger from other substances, especially organic compounds, in that fishes swim into solutions of these and after short stays avoid pure water and die.

7. The time it takes a body of water to recover if it has once been depleted must be considered. It has been shown that a whole association of plants and animals must re-develop in places of this sort. If a pine forest is destroyed by fire, fire weeds grow up followed by cottonwoods or birches and after a long time pines again. A similar slow process must take place in depleted waters.

8. There is danger from decisions made without investigation of a particular case. One important reason for this is that poisons are in some cases rendered much less toxic by salts in solution in the water polluted and in other cases they are rendered much more toxic by the salts present.

9. We need a new system of bookkeeping in dealing with these matters. The value of a waste is not simply the value of the products which may be prepared from it after the cost of recovery has been deducted, but from the value must be substracted all damage which the untreated waste does to water supply, fisheries, etc. That is, the needs of the entire community must be considered, and not merely those of a few individuals.